LM6023B

LCD Module User Manual

Shenzhen TOPWAY Technology Co., Ltd.

Rev.	Descriptions	Release Date
0.1	Prelimiay release	2004-03-26
0.2	Typing Correction on BIAS setting	2007-11-07

Table of Content

1. Basic Specifications 3
1.1 Display Specifications 3
1.2 Mechanical Specifications 3
1.3 Block Diagram 3
1.4 Terminal Functions 4
2. Absolute Maximum Ratings 5
3. Electrical Characteristics 5
3.1 DC Characteristics 5
3.2 LED Backlight Circuit Characteristics 5
3.3 AC Characteristics 6
4. Function Specifications 9
4.1 Basic Setting 9
4.2 Resetting the LCD module 9
4.3 Display Memory Map 9
4.4 Display Commands 10
4.5 Basic Operating Sequence (example) 11
5. Design and Handling Precaution 13

1. Basic Specifications

1.1 Display Specifications

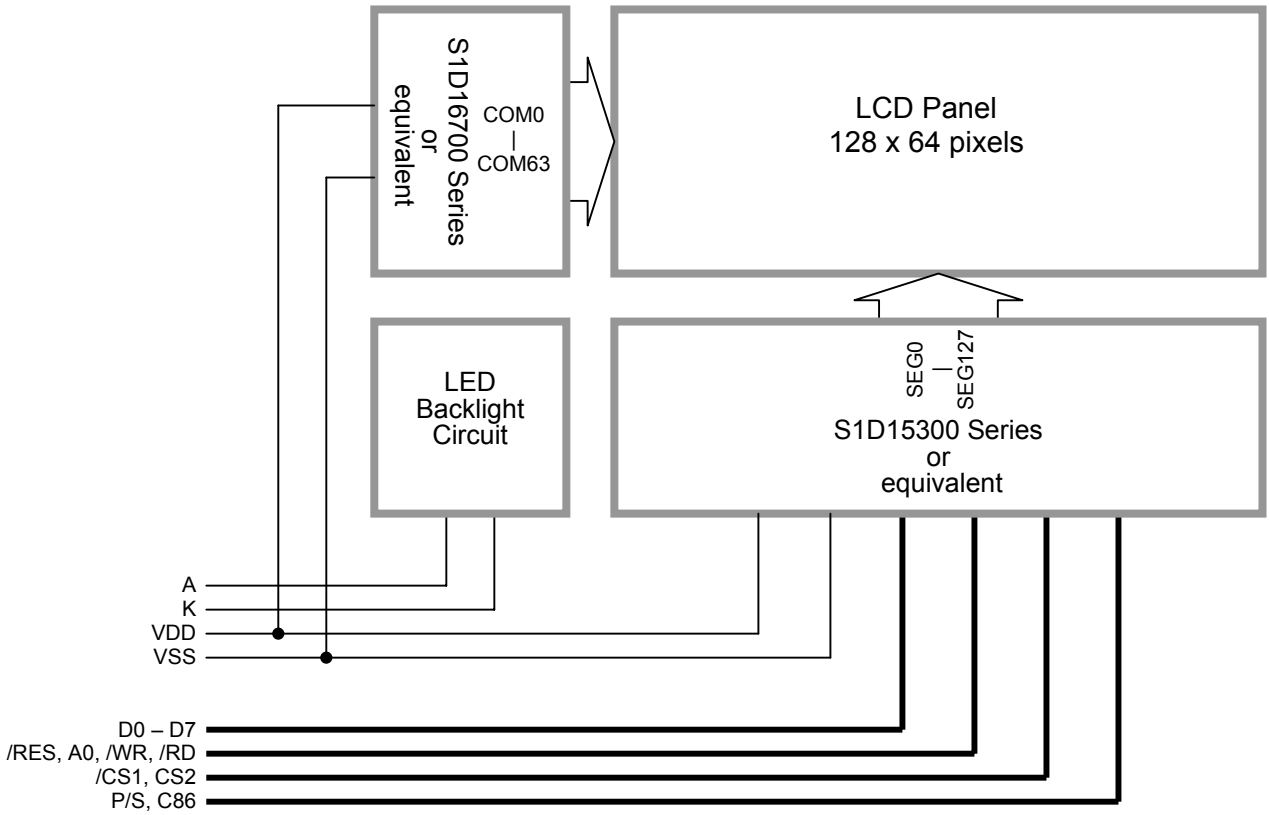
1) LCD Display Mode : STN, Positive, Transflective
2) Display Color : Display Data = “1” : Deep Blue (*1)
: Display Data = “0” : Light Gray (*2)
3) Viewing Angle : 6H
4) Driving Method : 1/65 duty, 1/8 bias
5) Back Light : White LED backlight

Note:
*1. Color tone may slightly change by Temperature and Driving Condition.
*2. The Color is defined as the inactive / background color

1.2 Mechanical Specifications

1) Outline Dimension : 113.0 x 65.0 x 15.3MAX
(See attached Outline Drawing for details)

1.3 Block Diagram



1.4 Terminal Functions

<table>
<tr><th>Pin No.</th><th>Pin Name</th><th>I/O</th><th>Descriptions</th></tr>
<tr><td>1</td><td>VSS</td><td>Supply</td><td>0V Supply, Ground (0V)</td></tr>
<tr><td>2</td><td>VDD</td><td>Supply</td><td>Positive Power Supply</td></tr>
<tr><td>3</td><td>/RES</td><td>Input</td><td>Reset signal pin
/RES=LOW: Initialization is executed
/RES=HIGH: Normal</td></tr>
<tr><td>4</td><td>P/S</td><td>Input</td><td>Serial / Parallel interface select pin.
P/S=HIGH: Parallel interface selected
P/S=LOW: Serial interface selected
<table>
<tr><th>P/S</th><th>Chip Select</th><th>Data / Command</th><th>Data</th><th>Read / Write</th><th>Serial Clock</th></tr>
<tr><td>HIGH</td><td>/CS1, CS2</td><td>A0</td><td>D0-D7</td><td>/RD, /WR</td><td>-</td></tr>
<tr><td>LOW</td><td>/CS1, CS2</td><td>A0</td><td>SI (D7)</td><td>Write only</td><td>SCL (D6)</td></tr>
</table>
In serial interface mode:
- no data can be read from RAM
- D0 to D5 are HZ
- /RD and /WR must be fixed HIGH or LOW</td></tr>
<tr><td>5
6</td><td>/CS1
CS2</td><td>Input</td><td>Chip Select inputs
/CS1=LOW, CS2=HIGH: Data IO is enabled
/CS1=HIGH, CS2=LOW: Data IO is disabled, D0 - D7 will be “HZ”</td></tr>
<tr><td>7</td><td>C86</td><td>Input</td><td>Microprocessor interface select pin.
C86=HIGH: 6800 series microprocessor interface
C86=LOW: 8080 series microprocessor interface</td></tr>
<tr><td>8</td><td>A0</td><td>Input</td><td>Control / Display data flag input.
A0=HIGH: data on D0 to D7 is display data
A0=LOW: data on D0 to D7 is control data</td></tr>
<tr><td>9</td><td>/WR(R/W)</td><td>Input</td><td>In 8080 interface mode:
Write enable input, active LOW
In 6800 interface mode:
R/W=HIGH: Read mode selected
R/W=LOW: Write mode selected</td></tr>
<tr><td>10</td><td>/RD(E)</td><td>Input</td><td>In 8080 interface mode: Read enable input, active LOW
In 6800 interface mode: Enable Clock Signal, active HIGH</td></tr>
<tr><td>11–18</td><td>D0 –D7
(SI),(SCL)</td><td>I/O</td><td>8-bit bi-directional data bus
In parallel interface mode: 8-bit data I/O
In serial interface mode: D7=SI(Serial data input), D6=SCL(Serial clock input)</td></tr>
<tr><td>19</td><td>A</td><td>Supply</td><td>Backlight positive Supply</td></tr>
<tr><td>20</td><td>K</td><td>Supply</td><td>Backlight negative Supply</td></tr>
</table>

2. Absolute Maximum Ratings

Items	Symbol	Min.	Max.	Unit	Condition
Supply Voltage	V_{DD}	0	5.8	V	V_{SS} = 0V
Input Voltage	V_{IN}	0	V_{DD}	V	V_{SS} = 0V
Operating Temperature	T_{OP}	-20	70	°C	No Condensation
Storage Temperature	T_{ST}	-20	80	°C	No Condensation

Cautions:
Any Stresses exceeding the Absolute Maximum Ratings may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

3. Electrical Characteristics

3.1 DC Characteristics

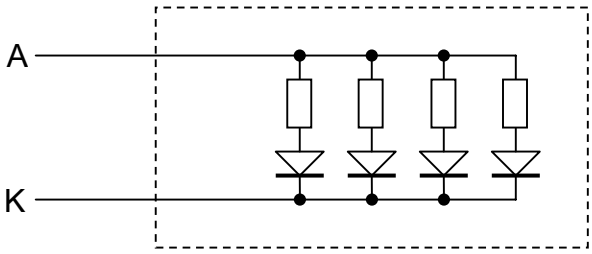
V_{SS}=0V, V_{DD}=5.0V, T_{OP}=25°C

Items	Symbol	MIN.	TYP.	MAX.	Unit	Condition / Application Pin
Operating Voltage	V_{DD}	4.5	5.0	5.5	V	VDD
Input High Voltage	V_{IH}	0.8xV_{DD}	-	V_{DD}	V	/RES,P/S,/CS1,CS2,C86,
Input Low Voltage	V_{IL}	0	-	0.2xV_{DD}	V	A0,/WR,/RD,D0~D7
Output High Voltage	V_{OH}	0.7xV_{DD}	-	V_{DD}	V	I_{OH}=-0.3mA, D0~D7
Output Low Voltage	V_{OL}	0	-	0.3xV_{DD}	V	I_{OL}=0.3mA, D0~D7
Operating Current	I_{DD}	-	0.4	1.5	mA	VDD, VSS
Sleep Mode Current	I_{DDS}	-	-	2	μA	VDD, VSS

3.2 LED Backlight Circuit Characteristics

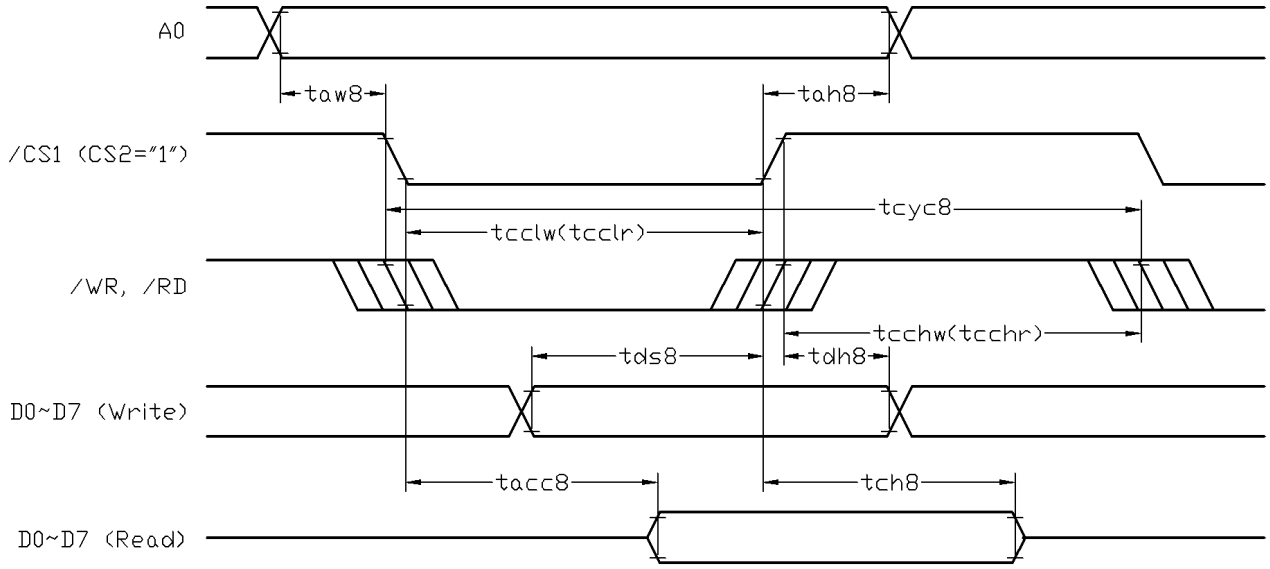
V_K=0V, If_A=80mA, T_{OP}=25°C

Items	Symbol	MIN.	TYP.	MAX.	Unit	Applicable Pin
Forward Voltage	Vf_A	-	4.9	-	V	A
Forward Current	If_A	-	-	120	mA	A



3.3 AC Characteristics

3.3.1 8080 Mode System Bus Timing

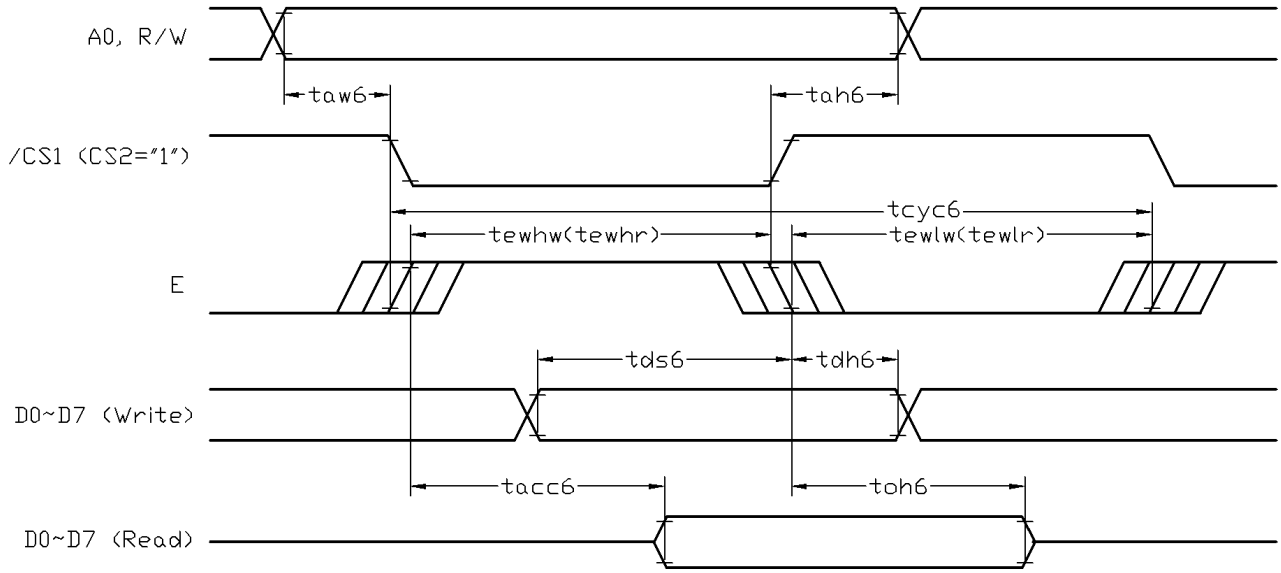


V_{SS}=0V, V_{DD}=5V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
Address hold time (A0)	tah8	20	-	-	ns
Address setup time (A0)	taw8	20	-	-	ns
System cycle time	tcyc8	332	-	-	ns
Control LOW pulse width (/WR)	tcclw	60	-	-	ns
Control LOW pulse width (/RD)	tcclr	140	-	-	ns
Control HIGH pulse width (/WR)	tcchw	200	-	-	ns
Control HIGH pulse width (/RD)	tcchr	140	-	-	ns
Data setup time	tds8	40	-	-	ns
Data hold time	tdh8	20	-	-	ns
/RD access time (*2)	tacc8	-	-	140	ns
Output disable time (*2)	tch8	-	-	100	ns

Note:
*1. Input signal rise/fall time should be less than 12ns
*2. CL=100pF

3.3.2 6800 Mode System Bus Timing

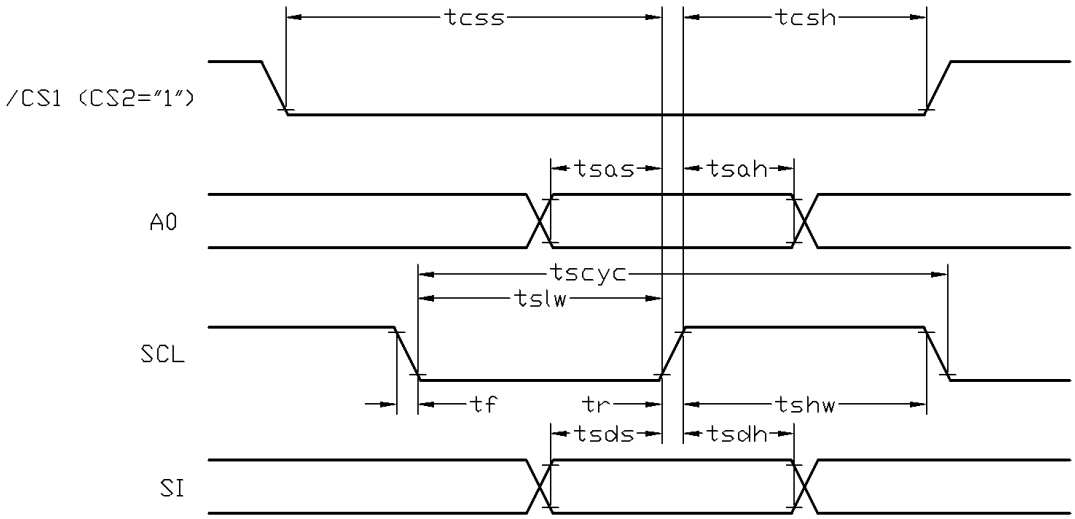


V_{SS}=0V, V_{DD}=5V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
System cycle time	tcyc6	332	-	-	ns
Address setup time	taw6	20	-	-	ns
Address hold time	tah6	20	-	-	ns
Data setup time	tds6	40	-	-	ns
Data hold time	tdh6	20	-	-	ns
Output disable time (*2)	toh6	-	-	100	ns
Access time (*2)	tacc6	-	-	140	ns
Enable High pulse width (Read)	tewhr	140	-	-	ns
Enable High pulse width (Write)	tewhw	60	-	-	ns
Enalbe Low pulse width (Read)	tewlr	140	-	-	ns
Enable Low pulse width (Write)	tewlw	200	-	-	ns

Note:
*1. Input signal rise/fall time should be less than 12ns
*2. CL=100pF

3.3.3 Serial Interface Timing

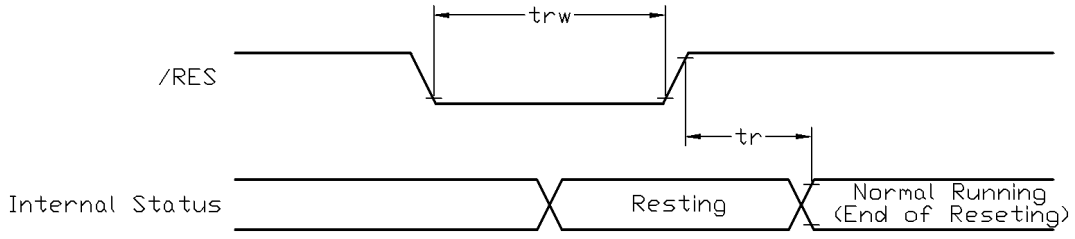


V_{SS}=0V, V_{DD} =5V, T_{OP} =25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
Serial clock cycle	tscyc	500	-	-	ns
Serial clock High pulse width	tshw	200	-	-	ns
Serial clock Low pulse sidth	tslw	150	-	-	ns
Address setup time	tsas	100	-	-	ns
Address hold time	tsah	400	-	-	ns
Data setup time	tsds	100	-	-	ns
Data hold time	tsdh	100	-	-	ns
CS serial clock time	tcss	60	-	-	ns
CS serial clock time	tcsh	200	-	-	ns

Note:
*1. Input signal rise/fall time should be less than 12ns

3.3.4 Reset Timing



V_{SS}=0V, V_{DD}=5V, T_{OP}=25°C

Item	Symbol	MIN.	TYP.	MAX.	Unit
Reset time	tr	1	-	-	μs
Reset LOW pulse width	trw	1	-	-	μs

Note:
*1. Input signal rise/fall time should be less than 12ns

4. Function Specifications

4.1 Basic Setting

To drive the LCD module correctly and provide normally display, please use the following setting

- Initial Display Line = 0
- ADC = 0 (normal)
- Normal/Reverse Display = Normal
- Entire Display ON/OFF = OFF (normal)
- LCD Bias = 1/8
- Set Output Status Register = normal
- Set Power Control: voltage follower=ON, voltage booster=ON, voltage regulator=ON
- Display ON/OFF = ON

Note:
*1. These setting/commands should issue the LCD module while start up.
*2. See the Display Commands section for details.

4.2 Resetting the LCD module

The LCD module should be initialized by using /RES terminal.

While turning on the VDD and VSS power supply, maintain /RES terminal at LOW level. After the power supply stabilized, release the reset terminal (/RES=HIGH)

4.3 Display Memory Map

Page address	data	LCD Display (front view)
0	D0 : D7	128x64 pixels
1	D0 : D7	
2	D0 : D7	
3	D0 : D7	
4	D0 : D7	
5	D0 : D7	
6	D0 : D7	
7	D0 : D7	
Column Address		00h → 7Fh

Note:
*1. Initial Display Line = 0
*2. ADC=0
*3. Output Status Register = normal

4.4 Display Commands

No.	Instructions	Code										Function
		A0	/RD	/WR	D7	D6	D5	D4	D3	D2	D1	D0	
1	Display ON/OFF	0	1	0	1	0	1	0	1	1	1	0/1	Turns on LCD when goes high, Turns off LCD when goes low
2	Initial Display Line	0	1	0	0	1	Start display address						Specifies display RAM location for first line of display
3	Set Page Address	0	1	0	1	0	1	1	Page Address				Set the display RAM page address
4.1	Set Column Address (Upper-4-bits)	0	1	0	0	0	0	1	Col. Add. Upper				Set the upper-4-bit of column address counter
4.2	Set column Address (Lower-4-bits)	0	1	0	0	0	0	0	Col. Add. Lower				Set the lower-4-bit of column address counter
5	Read Status	0	0	1	Status				0	0	0	0	Read the internal status D4=RESET, 1=resetting, 0=normal D5=Display ON/OFF, 1=off, 0=on D6=ADC Flag, D7=BUSY Flag, 1=busy, 0=ready
6	Write Display Data	1	1	0	Display Data								Write data into the display RAM
7	Read Display Data	1	0	1	Display Data								Read data form the display RAM
8	ADC Select	0	1	0	1	0	1	0	0	0	0	0/1	Sets the Column Address direction 0 = Normal display 1 = flipped in x direction
9	Normal/Reverse Display	0	1	0	1	0	1	0	0	1	1	0/1	Normal indication when low Full indication when high
10	Entire Display ON/OFF	0	1	0	1	0	1	0	0	1	0	0/1	0 = Normal display 1 = All-on display
11	Set LCD Bias	0	1	0	1	0	1	0	0	0	1	0/1	Set the LCD driving voltage bias 0 = 1/8BIAS 1 = 1/6BIAS
12	Read-Modify-Write	0	1	0	1	1	1	0	0	0	0	0	Enter the “Read-Modify-Write” mode column address counter will increase in each “Write Display Data”, and will not increase in each “Read Display Data command”
13	End	0	1	0	1	1	1	0	1	1	1	0	Clear the “Read-Modify-Write” mode
14	Reset	0	1	0	1	1	1	0	0	0	1	0	Resets the internal functions
15	Set Output Status Register	0	1	0	1	1	0	0	0/1	*	*	*	Set the COM scanning direction 0 = Normal display 1 = flipped in y direction * = don’t care terms
16	Set Power Control	0	1	0	0	0	1	0	1	Power Status			Set the power circuit operation mode D0 = LCD Supply Voltage Follower D1 = LCD Supply Voltage Regulator D2 = LCD Supply Voltage Booster (1=ON, 0=OFF)
17	Set Electronic Control Register	0	1	0	1	0	0	Electronic Control value					Set Electronic Vol. value (Display contrast value)
18	Set Standby (Static Indicator control)	0	1	0	1	0	1	0	1	1	0	0/1	Set the status, when Power Save 0 = sleep mode will be entered, (static indicator off) 1 = standby mode will be entered (static indicator on)
19	Power Save	-	-	-	-	-	-	-	-	-	-	-	Compound command step 1: display ON/OFF= OFF step 2: Entire Display ON/OFF = ON

Note: *1. Do not use any other command not listed, or the system malfunction may result.
*2. For the details of the Display Commands, please refer to S1D15300 Series data sheet.

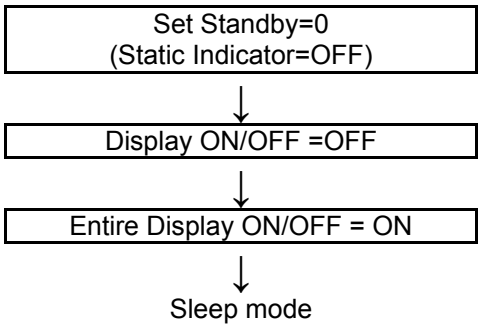
4.5 Basic Operating Sequence (example)

4.5.1 Initialization Sequence

	Code Function										
	A0	D7	D6	D5	D4	D3	D2	D1	D0	hex	Note
Turn on Power Supply VDD & VSS While maintaining /RES at LOW	-	-	-	-	-	-	-	-	-	-	-
↓ Wait until power supply is stabilized	-	-	-	-	-	-	-	-	-	-	-
↓ Release the /RES Reset Signal (/RES = HIGH)	-	-	-	-	-	-	-	-	-	-	See AC Characteristics section for timing details
↓ LCD bias = 1/8	0	1	0	1	0	0	0	1	0	A2	LCD panel Characteristic
↓ ADC = normal	0	1	0	1	0	0	0	0	0	A0h	No flip on x-direction (SEG)
↓ Output Status Register=normal	0	1	1	0	0	0	0	0	0	C0h	No flip on y-direction (COM)
↓ Init Display Line=0	0	0	1	0	0	0	0	0	0	40h	i.e. Display RAM “page 0 - D0” Matched to top line of the LCD
↓ Electronic Control Register=10000b	0	1	0	0	1	0	0	0	0	90h	Set to the middle of the range It may be adjusted for achieving the best display contrast
↓ Power Control LCD voltage follower = on LCD voltage regulator = on LCD voltage booster = on	0	0	0	1	0	1	1	1	1	2Fh	Turn on all the internal power circuit for driving the LCD normally
↓ Display ON/OFF = ON	0	1	0	1	0	1	1	1	1	AFh	Turn on the LCD display
↓ Set Page Address = 0	0	1	0	1	1	0	0	0	0	B0h	Specify the Display Data RAM page address going to write = 0
↓ Set Column Address = 0	0	0	0	0	1	0	0	0	0	10h	Specify the Display Data RAM column address going to write = 0 (two command)
	0	0	0	0	0	0	0	0	0	00h	
↓ Write Display Data	1	Display Data									Write data to Display Data RAM. After write, the internal Column Address Counter will be increased by 1 automatically
↓ Write Other Display Data …											

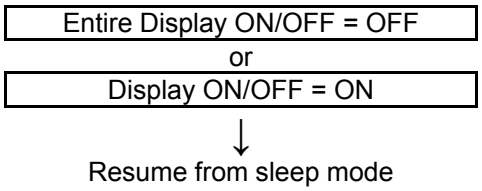
4.5.2 Power Save Sequence (sleep mode)

Going into Sleep Mode (A Compound Command)



Code Function										Note
A0	D7	D6	D5	D4	D3	D2	D1	D0	hex	
0	1	0	1	0	1	1	0	0	ACh	Turn off the Static Indicator
0	1	0	1	0	1	1	1	0	AEh	Turn off the LCD display
0	1	0	1	0	0	1	0	1	A5h	Display all on command

Resume form Sleep mode



Code Function										Note
A0	D7	D6	D5	D4	D3	D2	D1	D0	hex	
0	1	0	1	0	0	1	0	0	A4h	Display all on command
0	1	0	1	0	1	1	1	1	AFh	Turn on the LCD display

4.5.3 Power off the LCD Module

It recommends that enter sleep mode before power off the LCD module.

4.5.4 Refreshing The LCD Module

It recommends that the operating modes and display contents be refreshed periodically to prevent the effect of unexpected noise.

5. Design and Handling Precaution

1. The LCD panel is made by glass. Any mechanical shock (eg. dropping form high place) will damage the LCD module.
2. Do not add excessive force on the surface of the display, which may cause the Display color change abnormally.
3. The polarizer on the LCD is easily get scratched. If possible, do not remove the LCD protective film until the last step of installation.
4. Never attempt to disassemble or rework the LCD module.
5. Only Clean the LCD with Isopropyl Alcohol or Ethyl Alcohol. Other solvents (eg. water) may damage the LCD.
6. When mounting the LCD module, make sure that it is free form twisting, warping and distortion.
7. Ensure to provide enough space (with cushion) between case and LCD panel to prevent external force adding on it, or it may cause damage to the LCD or degrade the display result.
8. Only hold the LCD module by its side. Never hold LCD module by add force on the heat seal or TAB.
9. Never add force to component of the LCD module. It may cause invisible damage or degrade of the reliability.
10. LCD module could be easily damaged by static electricity. Be careful to maintain an optimum anti-static work environment to protect the LCD module.
11. When peeling off the protective film from LCD, static charge may cause abnormal display pattern. It is normal and will resume to normal in a short while.
12. Take care and prevent get hurt by the LCD panel sharp edge.
13. Never operate the LCD module exceed the absolute maximum ratings.
14. Keep the signal line as short as possible to prevent noisy signal applying to LCD module.
15. Never apply signal to the LCD module without power supply.
16. IC chip (eg. TAB or COG) is sensitive to the light. Strong lighting environment could possibly cause malfunction. Light sealing structure casing is recommend.
17. LCD module reliability may be reduced by temperature shock.
18. When storing the LCD module, avoid exposure to the direct sunlight, high humidity, high temperature or low temperature. They may damage or degrade the LCD module